
Space Weather Technical Forecast

Issued on Saturday, 07 September 2024 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-class flares likely through the period. Chance of G1/Minor Geomagnetic Storm conditions later Day 1 (07 Sep). Slightly increasing chance of S1/Minor Radiation Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has increased to Moderate levels, with a solitary M-flare peaking M1.6 from AR3813 at 07/0746 UTC. There are currently nine sunspot regions on the visible disc with Ex-AR3807 now passed beyond the southwest limb. AR3806 and AR3808 in the southwest and AR3813 and AR3815 in the southeast maintain moderate size and complexity. Both pairs of sunspots lie in close proximity to each other on the disc, with some interaction of their respective magnetic fields. Of these, AR3813 in the southeast remains the largest region with the emergence of at least one delta spot over the past 24 hours. A region to the east of AR3813 has been numbered AR3815 and previously developed a minor delta spot in its trailing portion, although that has since faded. AR3806 and AR3608 have generally decayed, however a small delta spot has formed within the main spot of the latter. The remaining regions are either small, simple groups, or larger but mature areas.

A filament eruption from the southeast disc near AR3813 and AR3815 on 06 Sep has been modelled and considered to pass well below Earth orbit. A further filament eruption from the vicinity of AR3813 on 07 Sep appears to have resulted in a CME and will be analysed for any potential Earth-directed component once more coronagraph imagery is available.

Solar Wind / Geomagnetic Activity: The solar wind as measured by ACE and DSCOVR at L1 varied between slow-ambient and slightly elevated levels, generally between 350-420km/s. Density was mainly below average, but increased to average levels late in the period. The Interplanetary Magnetic Field, Bt, was predominantly Weak, but has strengthened to become persistently Moderate from around 07/0300 UTC (peak 10nT). The north-south component, Bz, varied weakly and erratically throughout (between +/-7nT). Phi angle was almost exclusively negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has continued to slowly decline following the response to the M5.5 flare on 01 Sep. It remains above normal background levels, but is well below the S1/Minor Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to Moderate levels, peaking at 187 pfu at 06/1255 UTC. The corresponding 24-hour fluence showed a falling then steady trend well below the Active threshold, with 2.84e6 integrated pfu observed at 07/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely through the period, with a very slight chance of isolated X-class (Strong) flares.

Solar Wind / Geomagnetic Activity: A CME that left the Sun on 07 Sep from the southeast disc is awaiting analysis to determine if there is an Earth-directed component. Otherwise, the onset of a weak high-speed stream associated with CH65/+ in the northern hemisphere is

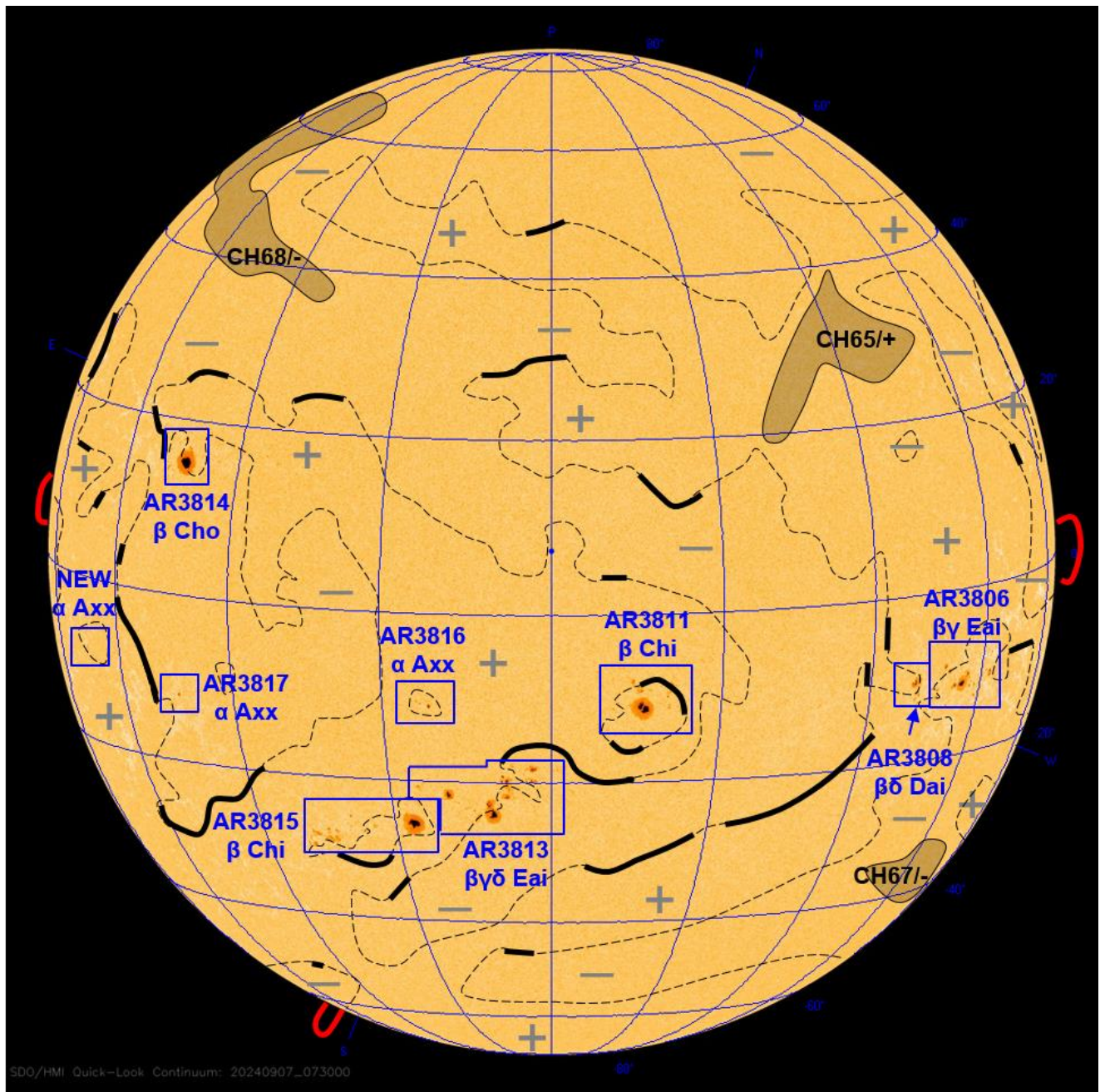
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expected late Day 1 (07 Sep) or perhaps Day 2 (08 Sep), persisting until Day 3 (09 Sep), resulting in slightly elevated wind speeds. Otherwise mainly background wind speeds are expected.

Geomagnetic activity is forecast to be largely Quiet to Unsettled, but expected to reach Active levels later Day 1 (07 Sep), or perhaps Day 2 (08 Sep) with a chance of peak G1/Minor Storm (Kp5) conditions owing to the onset of the anticipated coronal hole fast wind. The forecast for the end of the period may change following analysis of the filament eruption from 07 Sep, should any component of the resultant CME be determined to be Earth-directed.

Energetic Particles / Solar Radiation: High energy proton flux is currently above normal background levels, but well below the S1/Minor radiation storm threshold. There is a slight chance (increasing to a chance from Day 3 (09 Sep) of the S1/Minor storm threshold being reached. High energy electron flux is expected to remain at background to moderate levels, perhaps rising late in the period following any HSS effects to see diurnally high levels. There is a very slight chance of fluence reaching the Active ($1e8$ integrated pfu) threshold on Day 4 (10 Sep).

Figure 1. Solar Analysis Valid 07/0730 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A filament eruption from the southeast disc near AR3813 and AR3815 on 06 Sep has been modelled and considered to pass well below Earth orbit. A further filament eruption and concurrent M1.6 flare from the vicinity of AR3813 on 07 Sep appears to have resulted in a CME and will be analysed for any potential Earth-directed component once more coronagraph imagery is available.

Although initially in a near background solar wind regime, CH65/+ in the northwest disc is likely to connect with Earth, beginning either late Day 1 (07 Sep), or perhaps on Day 2 (08 Sep). Slightly elevated wind speeds are considered likely at peak between Days 1-3 (07-09 Sep). This coronal hole on the previous rotation was in a slightly different location, and the solar wind was contaminated by CME arrivals, so persistence forecasting is not reliable. However, the coronal hole being of positive polarity it is more likely to give a notable geomagnetic response at Earth at this time of year.

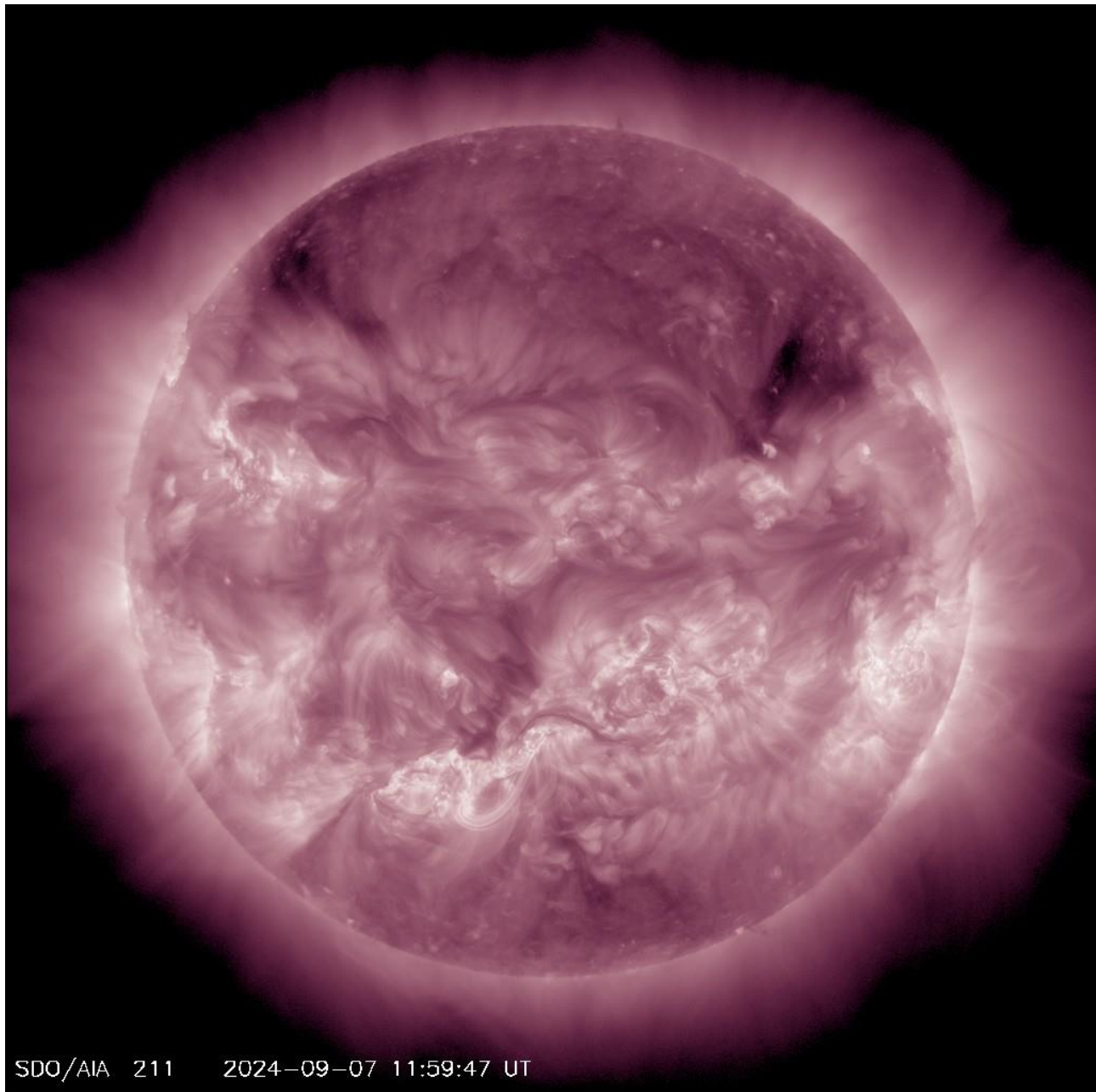
MOSWOC Enlil is continues to significantly overestimate observed solar wind speeds, modelling a broad and strong coronal hole which does not exist.

Geomagnetic activity is forecast to be largely Quiet to Unsettled, but expected to reach Active levels later Day 1 (07 Sep), or perhaps Day 2 (08 Sep) with a chance of peak G1/Minor Storm (Kp5) conditions owing to the onset of the anticipated coronal hole fast wind. The forecast for the end of the period may change following analysis of the filament eruption from 07 Sep, should any component of the resultant CME be determined to be Earth-directed.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

Figure 2: SDO/AIA 211 imagery at 07 Sep 1159 UTC. Coronal hole 65 located in the northwest disc.



Radio Blackouts - X-Ray Flares:

There are currently nine sunspot regions on the visible disc, including one unnumbered region, this located in the southeast.

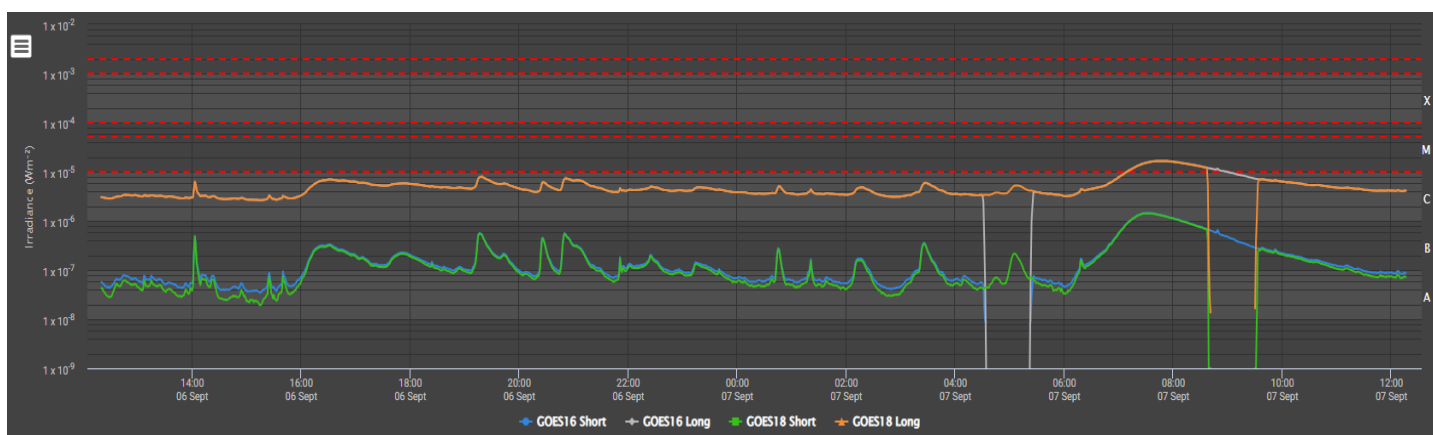
AR3813, in the southeast, remains the largest region and maintains a small delta configuration in the leading portion of the group and a larger delta configuration on one of the more mature trailing spots. The region in close proximity to the east of this, AR3815, has lost its marginal delta spot in the trailing region of the group, with negligible penumbra evident, resulting in a simplification of its classification. Sunspot pair AR3806 and AR3808 in the far southwest remain moderately complex regions. Although areal extent has generally decreased, a small delta spot has formed within the main spot of the latter.

The remaining regions are either small, simple groups, or larger but mature areas with limited growth or decay observed.

Activity has increased to Moderate levels following a slow-period M1.6 flare, peaking at 07/0746 UTC from AR3813. Further M-class flares are considered likely during the forecast period, with a very slight chance of an isolated X-class flare. The risk of M-flares decreases slightly by Day 4 (10 Sep) as AR3806 and AR3808 rotate over the west limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	65	65	65	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Latest GOES16/18 X-Ray flux trace





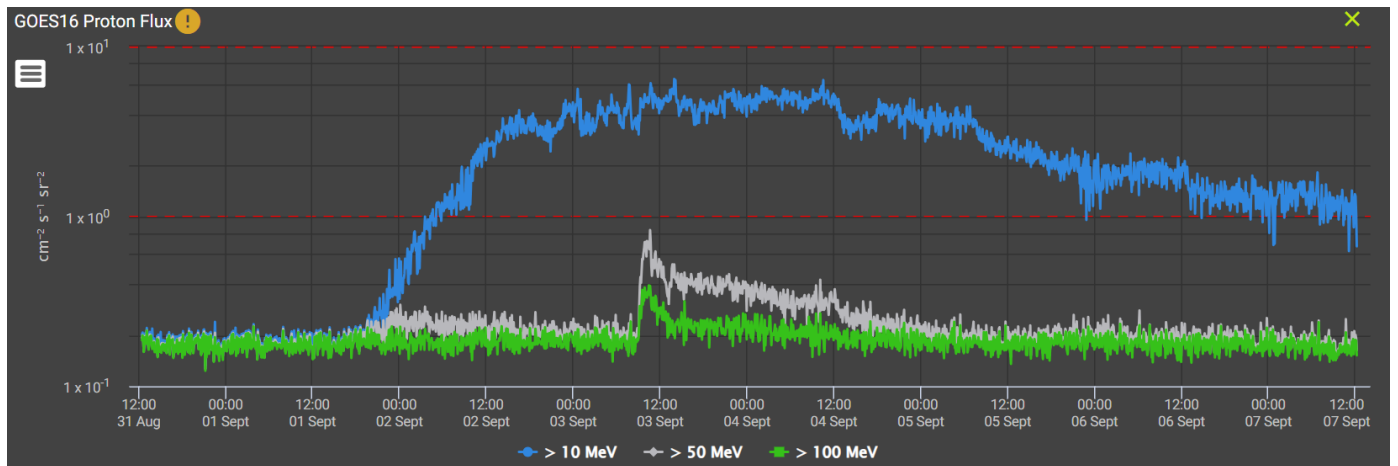
Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is above normal background levels, but slowly easing following the response to the large eruption and associated M5.5 flare off the southeast limb on 01 Sep. There is a slight chance (increasing to a chance from Day 3 (09 Sep) of the S1/Minor radiation storm threshold being reached. There are a number of candidate regions in the southern disc that could result in proton rich flares being observed, that move into increasingly geo-effective positions in the coming days.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	15	15	20	20
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: 7-day GOES 16 Proton flux trace



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux as observed by GOES-16 has been at mainly background levels. Any weak HSS from CH65/+ may result in a slight increase in the electron flux later in the period, with levels becoming mainly moderate, and a chance of reaching High levels during diurnal peak.

Overall, the 24 hour fluence is expected to remain below the Active ($1\text{e}8$ integrated pfu) threshold, although with perhaps a rising trend late in the period after any HSS from CH65/+ starts to ease. Therefore, there is a very slight chance of exceeding the Active threshold on Day 4 (10 Sep). MOSWOC REFM will not be taking into account the upcoming potential HSS, but the overall trend of the fluence remaining below Active is accepted.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1\text{x}10^8$	No	1	1	1	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1\text{x}10^9$	No	1	1	1	1

Figure 5: GOES16 $>2\text{MeV}$ Electron Flux (above) and MOSWOC REFM forecast and recurrence (below)

